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Utilization of Carbohydrates by the Young Calf[1]

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Recent interest in milk replacers has led investigators to determine the extent of the utilization of mono- and disaccharides in young animals (1,2,3,4). However, there is very little information on the utilization of the more complex carbohydrates by young calves. The purpose of this experiment was to estimate the response in blood sugar when various carbohydrates were given to the young calves. The extent to which various enzymes might enhance this effect was also studied. The results of such a study may prove useful in indicating the relative value of these carbohydrates in milk replacers.

Young calves from 5 to 53 days of age were used. Some were fed whole milk while others were fed a grain mixture, silage and alfalfa hay in addition to whole milk. During the test period, the calves were fasted overnight and then fed the various carbohydrates in the morning at the rate of 2.0 - 2.5 gm per lb of body weight. The carbohydrates were dissolved or suspended in warm water and fed from a pail. The carbohydrates used were glucose, lactose, maltose, sucrose, dextrin, corn starch, raw corn, cooked corn, dehydrated potato, and cooked barley. The cereal products were finely ground before use. The enzymes used were invertase, Mylase S A (a fungal amylase), and pancreatic diastase[2].

The amount of the enzymes added to the carbohydrates are given in Table 1. The concentrations of the reducing sugars in the jugular blood at 1/2 or 1 hour intervals for five hours after feeding were determined by the method of Somogyi (5). The calves were returned to their regular rations after the fifth hour.

The results are shown in Table 1 and Figure 1. In the graphical presentation, the blood sugar concentrations were averaged and presented as a single line except in cases where separation into age or treatment effects were appropriate.

1/ Paper presented at the annual meeting of the American Dairy Science Association, June 15-17, 1959, at University of Illinois, Urbana, Illinois.

2/ Mylase S A and invertase were furnished by Wallerstein Co., Inc., New York City, and pancreatic diastase was furnished by Cudahy Laboratories, Omaha, Nebraska. (Mention of companies and products in this paper does not constitute endorsement by the U. S. Department of Agriculture over other firms and products not mentioned.)

The results are listed below according to the ingredients fed.

Water: Relatively constant blood sugar values were found in calves fed water. There was a tendency for the sugar values to be lower at the older ages (Figure 1).

Glucose: The peak response was found between 1 and 2 hours after feeding. The difference between the initial and the peak blood sugar level was approximately 110 mg %. The increase in blood sugar did not vary in any definite pattern with respect to age. The averaged increase was almost double that reported by Dollar and Porter (1) but only slightly more than the value found by Voelker et al. (6).

Lactose: The maximum blood sugar concentration was found 1 - 2 hours after feeding lactose. There were some differences in the blood sugar values between calves under 20 days and those over 20 days of age but the difference between the averages was not as much as that noted by Dollar and Porter (1). They found an increase of 55 mg % in blood sugar concentration in calves 6 to 14 days of age and an increase of 27% for calves 30 to 34 days of age. The increases found in this experiment were 90 mg % for calves under 20 days and 108 mg % for calves over 20 days of age. The blood sugar values for both of our groups were essentially the same between the second and fourth hour after feeding.

Dextrin: Very small changes in blood sugar levels were observed when only dextrin was fed. There was a trend towards a larger increase as age increased. The increase in blood sugar was not altered by the addition of the enzymes used except in one case (enzyme 1 at 4%). This large increase was not obtained in subsequent trials.

Sucrose: When sucrose was given alone there was practically no increase in blood sugar level at any age up to forty days. Sucrose was evidently not hydrolyzed or utilized by the young calf. When sucrose plus 1.0 or 0.5% invertase was given, the increase in blood sugar was equal to or greater than that when glucose was fed. This occurred in calves from 5 to 39 days of age. The addition of this enzyme at a lower concentration (0.1%), produced a small increase that was only 1/6 of that found when invertase was added at the 0.5% level to calves 7 days of age.

Maltose: Very little increase in blood sugar was found in calves 7 days of age when maltose was fed either with or without the added enzymes. An average increase of 45 mg. % was found in two calves over 20 days of age. Dollar and Porter (1) showed no increase for calves 3 to 7 days of age and an increase of approximately 10 mg % was indicated for calves 20 to 28 days of age. Other investigators (4) have indicated that there was a limited increase in blood sugar when maltose was given.

Corn, corn starch, cooked corn starch: All three of the products produced little change in blood sugar concentration. The response was not materially altered by the addition of enzymes. Corn gave a more consistent increase than did the corn starches but all three products were apparently not hydrolyzed by the young calf.

Cooked corn and barley: Steamed or cooked corn from two commercial sources (A & B) and cooked barley were used. Cooked corn alone produced small changes in blood sugar level. However when both amylolytic enzymes were added there was an increase in the blood sugar level. (Table 1 and Figure 1). The increase was larger when both enzymes were added than when only the fungal amylase was added. It was also larger in the older calves. The one value obtained from feeding cooked barley was not as large as the value obtained from the corn products on calves at a similar age.

Dehydrated potato: A commercial instant mashed potato product when fed alone produced no change in blood sugar levels. When fed with amylolytic enzymes a distinct increase was obtained. The increase was small in a calf 10 days of age but larger in older calves.

The feeding of glucose and lactose to fasted calves produced a large increase in blood sugar levels. Maltose caused a small increase in older calves but corn (cooked or raw), corn starches, dehydrated potato, dextrin, or sucrose did not produce any increase in the blood sugar levels when fed to fasted calves. A noticeable increase in blood sugar levels occurred when certain enzymes were added to cooked cereals or dehydrated potato. Essentially no increase was found when these same enzymes were added to raw corn, corn starches, or dextrin. The heating and/or drying process may have retrograded starch in such a manner that the starch was not hydrolyzed by the enzymes used. The addition of invertase to sucrose produced an increase in blood sugar levels equal to that produced by glucose. The cost of sucrose plus 0.5% invertase is about 68% of that of glucose. It is possible that sucrose plus invertase could replace glucose or other carbohydrates in commercial milk replacers for calves. The use of certain cooked cereal products plus enzymes might also be a useful additive to milk replacers.

References

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Table 1 - Average increase in blood sugar in calves after consumption of various carbohydrates

	No. of calves	diet	Enzyme and conc. %	Age in Days 0-10	11-20	21-30	31-40	41-53
Water	1	milk	0	-5	-5	-3	-3	
Lactose	2	milk	0	83	52	86	149	
"	1	herd	0	13	96	145	61	
Glucose	1	milk	0	83	142	53	159	
Maltose	3	milk	0	5*	77			
"	1	herd	0			21		
"	1	herd	1&2,2.0-1.0	0				
Sucrose	2	milk	0	8	0	12	5	
"	3	milk	3,1.0	151			158*	
"	2	herd	3,0.5	212		80		
"	2	both	3,0.1	33*				
Dextrin	2	milk	0	-10	-6	2	8*	17
"	1	herd	0	6	9	10	2	4
"	1	milk	1,4.0				35	
"	2	herd	1,4.0			13	9	
"	3	milk	2,0.5				6*	16
"	1	herd	2,1.0		9			
"	2	herd	1&2,2.0-1.0			14*		
Corn starch	1	milk	0					-6
"	1	milk	1,2.0				4	
"	2	milk	2,1&0.5				-3	-4
"	1	milk	1&2,2.0-1.0			6		
Cooked corn starch	2	milk	1&2,2.0-1.0		10			-10
Corn	1	milk	0					8
"	4	milk	1&2,2.0-1.0		1*		20	8
Cooked corn(A)	3	milk	0		5	0	12	
"	1	milk	2,1.0		-2			
"	6	milk	1&2,2.0-1.0	13	24	48*	52	44
Cooked corn(B)	1	milk	2,1.0				27	
"	2	milk	1&2,2.0-1.0		-2	40		
Potato, dehydrated	1	milk	0			1		
"	1	milk	2,1.0		21			
"	2	milk	1&2,2.0-1.0	7		42		
"	1	herd	1&2,2.0-1.0				11	
Cooked barley	1	milk	1&2,2.0-1.0			25		

* Denotes averaged values.
Enzymes: 1 - pancreatic diastase
2 - mylase S A
3 - invertase

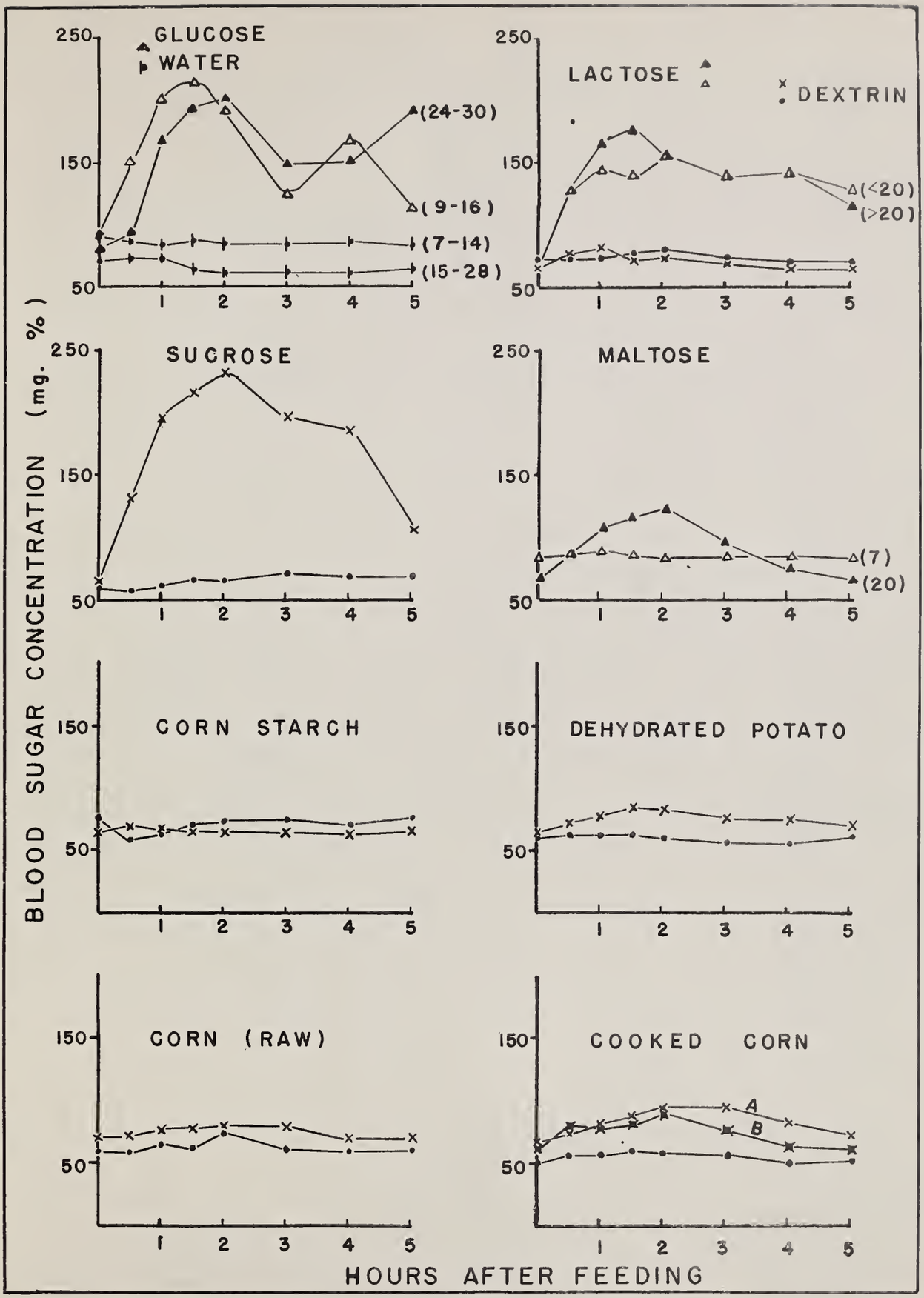

Figure 1 - Blood sugar concentrations of calves fed various carbohydrates. (Average ages, where pertinent, are indicated in parentheses; triangles and solid circles represent values obtained without enzymes; and crosses represent values obtained when enzymes were added to that carbohydrate.)